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Canada Centre for Mineral and Energy Technology

Centre canadien de la technologie des minéraux et de l'énergie

Efficiency and Alternative Energy Technology Branch

Direction de la technologie de l'efficacité énergétique et des énergies de remplacement

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91-01348/

MINUTES

SMALL COMMERCIAL WOODCHIP COMBUSTION TECHNOLOGY WORKSHOP, CHARLOTTETOWN, P.E.I. SEPTEMBER 11-14, 1989

PREPARED FOR:

Efficiency and Alternative Energy Technology Branch
Energy, Mines and Resources Canada
Ottawa, Ont.
September, 1989

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27pp

MICROMEDIA

CITATION

McCallum, B. Minutes: Small Commercial Woodchip Combustion Technology Workshop, Charlottetown, P.E.I., September 11-14, 1989. Efficiency and Alternative Energy Technology Branch, Energy, Mines and Resources Canada, Ottawa, Ontario. 1989 (24 pp.)

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Catalogue No. M91-7/74-1990E
ISBN. 0-662-17639-1

SUMMARY

This was the fourth workshop on small commercial woodchip combustion technology. The first was held in Fredericton in October, 1985; the second was held in Charlottetown in May, 1987. The 1987 workshop focused largely on Swedish small commercial woodchip combustion and fuel handling systems and their potential application in typical P.E.I. conversion sites. The third workshop was held in Clarence Creek, Ont. in June, 1988; it focused on the testing at l'Institut de recherche en technologie appropriée (IRTA) and limited field trials of Scandinavian residential and small commercial woodchip burners.

The September, 1989 workshop was more general. It included a tour of eight small commercial installations and one industrial-class site, as well as a review of work in the combustion and fuel handling areas. On the final day of the workshop there was a lengthy discussion on priorities for future research and development in the woodchip combustion field. The following priority areas were identified:

- the need to improve the cleanliness of holdfire combustion;
- the development and demonstration of lower-cost fuel handling systems;
- the preparation of a handbook on small commercial chipping;
- the development of a cost-effective technique for drying sawdust;
- the need to manufacture vertical tube boilers in Canada;
- the need for a newsletter for ongoing bioenergy information exchange.

These minutes have been prepared from workshop tapes and notes by Bruce McCallum. Every attempt was made to maintain the intent of the participants' comments. The order has sometimes been rearranged to improve continuity. Photos and drawings reproduced courtesy of the P.E.I. Department of Energy and Forestry; Jeremy Godfree; AFE Engineering; Bruce McCallum; and Jamforsen Energy Systems AB.

RÉSUMÉ

Voici le quatrième atelier sur la technologie de la combustion des copeaux de bois à petite échelle commerciale. Le premier a eu lieu à Fredericton, au mois d'octobre 1985; le second à Charlottetown, en mai 1987. Il portait principalement sur les systèmes de combustion des copeaux de bois à petite échelle commerciale et de manutention du combustible selon une méthode d'origine suédoise et son application à un site de conversion typique de l'Ile-du-Prince-Édouard. Le troisième atelier a eu lieu à Clarence Creek en Ontario au mois de juin 1988. Son but premier était de mettre à l'essai à l'Institut de recherche en technologie appropriée (IRTA) et ainsi que sur place de façon limitée des poêles scandinaves pour la combustion des copeaux de bois dans les résidences et à petite échelle commerciale.
L'atelier du mois de septembre 1989 présentait des notions plus générales. Les participants à l'atelier ont pu visiter huit petites installations commerciales ainsi qu'un site de niveau industriel en plus de survoler les connaissances dans le domaine de la combustion et de la manutention du combustible. Le dernier jour, les participants ont longuement discuté des priorités concernant la R - D à venir dans le domaine de la combustion des copeaux de bois. Ils ont déterminé les priorités suivantes :

- l'amélioration de la combustion lente quant à la propreté;
- le développement et la démonstration des systèmes de manutention du combustible;
- la préparation d'un manuel sur la production des copeaux de bois à petite échelle commerciale;
- le développement d'une technique rentable pour le séchage de la sciure de bois;
- la nécessité de fabriquer des chaudières à tube vertical au Canada;
- le nécessité de créer un bulletin pour communiquer l'information dans le domaine bioénergétique.

Le compte-rendu a été préparé à partir des notes et des rubans enregistrés lors de l'atelier par Bruce McCallum. L'on a essayé d'interpréter correctement les commentaires des participants. Aux fins de continuité, on a cependant dû réaménagé l'ordre dans lequel sont présentés les commentaires. Les photos et les dessins sont une gracieuseté du ministère de l'Énergie et des forêts de l'I.-P.-É., de Jeremy Godfree, de AFE Engineering, de Bruce McCallum et de Jamforsen Energy Systems AB.

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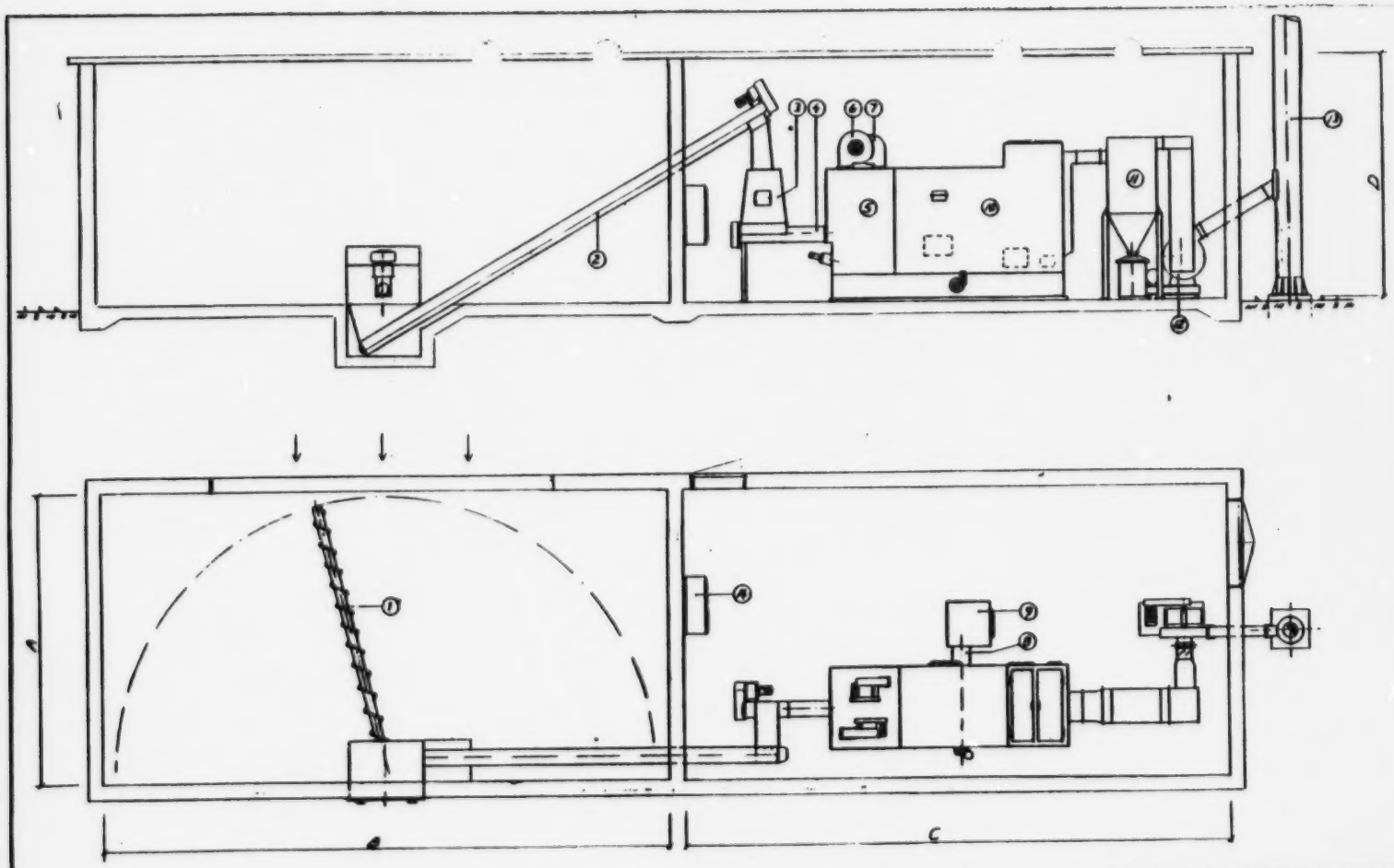


kW	g/m	A	B	C	D
150	500 000	3000	6000	7100	3900
250	850 000	---	---	7700	4100
350	1200 000	4000	8000	8100	---
500	1700 000	---	---	8700	4300
750	2 500 000	5000	10 000	9300	---
1000	3 500 000	---	---	9900	4500

Pendulum Screw Feed System

14		AUTOMATIKSCHRANK	AUTOMATIKSCHRANK	CONTROL PANEL
13		SKORSTEN	SCHORNSTEIN	STACK
12		RÖKGASFLÄKT	RAUCHGASGEBLÄSE	I.D. FAN
11		FÖRGASARANORD.	RAUCHGASREINIGER	DUST COLLECTOR
10		PANNA	KESSEL	BOILER
9		ASKBEHÅLLARE	ASCHEBEHÄLTER	ASH BIN
8		ASK- OCH SLAGGSKRUV	SCHLACKESCHNECKE	ASH SCREW
7		SEKUNDÄRLUFTFLÄKT	SEK. LUFTGEBLÄSE	SECONDARY AIR FAN
6		PRIMÄRLUFTFLÄKT	PRIM. LUFTGEBLÄSE	PRIMARY AIR FAN
5		FÖRBRÄNNINGSUGN	VERBRENNUNGSOFEN	FURNACE
4		MATNINGSSKRUV	BESCHICKUNGSSCHNECKE	INFEEDING SCREW
3		BRÄNSLEBEHÅLLARE	BRENNSTOFFBEHÄLTER	FUEL BIN
2		MOTORSKRUV	FÖRDERSCHNECKE	FEEDING SCREW
1		VINDELSKRUV	WENDELSCHNECKE	SCREW CONVEYOR

AB JÄRNFORSEN ENERGI SYSTEM	FASTBRÄNSLEELDAD VÄRMECENTRAL VERBRENNUNGSANLAGE MODIFIED HEATING PLANT	11/4-86	P-2201

BRUCE MCCALLUM—SCANDINAVIAN FUEL HANDLING DEVELOPMENTS

Bruce McCallum is a freelance consultant doing work in the bioenergy field. In June of 1989 he travelled to Sweden for the third time to further study small commercial woodchip combustion and fuel handling systems suited to small businesses and institutions, such as schools.

Bruce's work in PEI had led him to believe that there are many potential woodchip conversions that could be made in the 200 Kw to 400 Kw size range if lower cost, but still reliable woodchip systems can be built.

He showed slides of a number of woodchip systems in the Ljusdal area built by a man called Harde Goorde. The interesting thing about this man was he has developed intermediate scale technology between very small commercial and industrial scale systems.

He builds his own underfed stoker combustion cells. A 300 Kw unit sells for about $10,000 Cdn. His real innovations are in fuel feeding. He has developed a technique for installing the hydraulic cylinder that actuates the feed scrape at the back end of the scrape, actually in the fuel bin. This allows him to use the push stroke of the cylinder in conjunction with the push stroke of the scrape rather than the other way around as is normally the case. This approach allows him to use lower cost cylinders and to save a good deal of boiler room space that is normally allocated to the pulling cylinders. It also makes it easier to build systems that have much shorter feed trains which will also reduce plant costs.

In some cases he had also slanted the last scrape to achieve the angle and placement of the fuel train that he wanted. Bruce said that Harde Goorde's systems were very cheap. A complete 15 cubic metre fuel bin and automated feed system cost about $12,000.

Bruce felt that although the systems he saw were somewhat small, the techniques that Harde Goorde had employed could easily be scaled up to the size of the Queen's Arms Motel or larger.

Bruce then turned to systems built by a larger manufacturer called Jarnforsen which is located south of Jonkoping. Jarnforsen mainly builds high quality systems in the 500 Kw to 10 Mw size range.

A pendulum screw feeder normally has three moving components: the pendulum screw itself which rides on the floor of the fuel bin and which draws fuel to a junction box, and the inclined feed screw which conveys fuel to a small metering bin with a metering screw. The pendulum screw itself rests on the bin floor and it is pivoted at the feed end above the junction box. The screws come in 3,4, and 5 metre lengths and 7 to 9 inch (18-23 cm) diameters. Small teeth are welded to the flights of the screw to give it extra bite.

The screw itself is powered by one gear motor. In a rectangular fuel bin the pendulum screw travels through an arc of about 170°. A second gear motor moves the pendulum screw on the floor through its arc and then it reverses direction. The arc travel is very slow, only a few centimeters for each fuel feed cycle.

Bruce said that the pendulum screw is actually an old technology. It was used for sawdust systems for perhaps 50 years in Scandinavia. Jarnforsen have simplified the screw drive and adapted it to handle woodchips. For systems between 200 Kw and 2 Mw they often employ pendulum screw fuel

Bulk Carriers' Bruks Chipper

feeding mechanisms in order to gain a competitive advantage with other manufacturers. They also employ scrape systems. They claim that pendulum screws are actually more trouble free than scrapes. The pendulum screw itself is operating in a large bin and virtually never jams. The inclined and metering screws are at least 23cm (9 inches) in diameter with heavy flighting and this is the key to trouble free operation.

According to Bruce, the main advantage of pendulum screw systems is that they are cheaper than scrape systems. The bin construction is less costly because it is requires less reinforcement and no embedment steel for the scrapes.

Bruce feels that pendulum screws are a well developed technology that can make installations in the 200Kw to 400 Kw size range more economic and it is also quite suitable for systems up to 2 Mw. He strongly feels that it is time that we demonstrated a pendulum screw feeding system in Canada. The question is who will install the first one?

PAUL MCKNIGHT—CHIPPING IN PEI

Paul McKnight is a forester employed by the PEI Dept. of Energy and Forestry and he is responsible for monitoring fuel supply systems on PEI.

Paul noted that woodchipping in PEI goes back to 1976-77 when some initial production trials were conducted. He said that commercial production began in 1982 when the first chip plant at Kings County Memorial Hospital came on stream. Jim Hornby was contracted by the PEI Energy Corporation to supply about 2000 tonnes of chips. He purchased an old Trelan chipper to chip low grade wood. Production continued at the 2000 tonnes/year level until 1985 when the burners at the PEI Home and a few smaller installations came on stream.

Bulk Carriers Inc. of Cornwall signed a contract in December 1985 to supply 27,000 tonnes of chips over three years. Consumption in the first year was about 8000 tonnes.

In 1986 the pilot district heating system extended the PEI Home line to buildings that included the Charlottetown Hotel and City Hall. In 1986 a 3.5Mw chip plant at UPEI came on stream and in 1987 and 1988 it was interconnected with a number of buildings surrounding the university in what is now a 6Km district heating system.

Paul reported that the UPEI system now consumes 12-13,000 tonnes of chips per year. Total annual consumption in the Charlottetown area now amounts to about 15,000 tonnes. These chips are supplied by Bulk Carriers Limited which is based in Cornwall, PEI.

Paul then talked about the smaller chip suppliers in PEI. These included Larsen's Sawmill in Rose Valley which we visited. Larsens produce 600-700 tonnes of chips a year from sawmill slabs. Arsenault's sawmill in Abram Village supplies the western PEI plants with what is expected to be about 3300 tonnes of chips and sawdust(30%) mixture.

In eastern PEI, John Acorn has rebuilt a burned Bruks 1000CT mobile chipper and he supplies about 4300 tonnes of chips per year to five plants that heat two hospitals and five schools in that area.

Paul explained that, in December 1988, the original contract with Bulk Carriers Inc. was extended for a further three years. Bulk Carriers use mechanized feller-bunchers to windrow low -grade wood. They then chip along the windrows with a Bruks 800CT mobile chipper and transport the fuel in a container hook truck that can carry two containers.

The fuel is stockpiled on a large asphalt pad near the Queen Elizabeth Hospital over the summer months. They try to build long conical piles up to 10 metres high without any depressions so that the piles will shed water. If they remove the chips starting at the south end the sun will melt some of the frozen chip crust as they go. Paul noted that heating does occur in the piles but it does not reach critical temperatures. The material in the centre of the pile will dry to about 35% moisture content on a wet basis. The average overall moisture content from the outdoor storage is 45%. Sawdust plus bark is better than sawdust plus chips.

Paul reported that the outdoor storage has worked quite well except in the month of April when they end up trying to burn the frozen chunks that come from the crust or top of the pile. He felt that the most effective way to resolve this problem was to have an extra month's supply of fuel on hand to carry them right through into the next chipping season. That would allow this frozen residue to thaw and be mixed in with drier green chips during the summer months. The Corporation pays a bonus for dry chips but has some doubts about the economics.

TONY SHORT—THE NON-COMPACTING DRUM FEEDER

Tony Short is a Professor of Forest Engineering with UNB. In the fall of 1988 he took a sabbatical year and went to work with B.C. Research in Vancouver.

In his talk, Tony focussed on the NCDF, a drum feeder which is a variation on the original NCF (non-compacting feeder) developed by Nazmir Bundali and Dave Skeath of UKAF. The objective of his work was to design a device to supply fuel to a small burner at a controlled rate. They drew up a wide range of criteria that the feeder should meet. These included : that it should be quiet; it should fit into a small house or building; it should be amenable to shipping and later assembly; it should run on single phase power; it should have a capacity of 0.5 to 1 cubic metre; it should be under 1.2 metres (4 feet) high; it should handle a wide range of materials including chips, sawdust and shavings; it should handle irregular or oversized particles without stalling or self-destructing; it should be easy to fabricate; it should be easy to service with common tools; it should have easy access to critical areas; it should have a single motor; it should require a minimum of adjustment and be manually controllable; it should have low and high fuel level sensors; it should be suitable for coupling to a wide variety of combustors up to 200,000 Btu/hr. capacity; it should cost about $1,000.

The machine that they came up with has a 4-foot horizontal drum hopper or metering bin with a belt feeder or bin unloader that feeds fuel onto a variable speed belt which in turn feeds fuel to a hollow core flexible auger. Tony had a model prototype that he operated with hardwood sawdust as a fuel. He threw both a ball point pen and a small coin pouch into the sawdust bin, and both fed through the system successfully. The particles are never sliding over the belt surface. The bin feeder opening is fixed. The variable speed belt is used as the metering device to adjust for the differing flow rates that different materials will have. The intention is that the auger should never be filled to more than 20-30% of its capacity so as to avoid overloading it and compacting the fuel. It is the compaction of the fuel that results in the need for brute force to move the fuel. There is an access hatch on the side to permit the removal of oversize particles. The hollow core auger can accommodate many oversized objects and the drive will have an overload mechanism to shut the system down in the event of a jam. There was some thought to putting screening bars above the auger, but Dave Skeath thought that they might cause problems.

Tony explained that the drum is very simple and can be built in many shops. The spacers are common pipes. The belting is flexible and there should be little wear. In the latest version there are no pipe spacers in the top of the bin and metal forms part of the bin.

Jeremy Godfree asked if the metering belt could be deleted. Tony said that it could, but the auger could be flooded if you changed the fuel.

John Gulland asked if the unit had a shear pin. Tony said no, because people might put the wrong pin in it. He intended to use an overloading safety shutoff.

Dave Murray asked if there would be a problem if the metering belt stopped and the drum continued to rotate. Nazmir Bundali said that it would not be a problem for a short period, but that it should be avoided.

Charles LeMay asked when he was going to try one out and expressed an interest in trying one himself. Tony said that he would be hooking the prototype up in his garage soon and will run it over the winter. Nazmir said that he would like to see other machines run in the field and thought that it might be possible to build another unit for testing.

NAZMIR BUNDALI—CHIP HANDLING IN PEI

Nazmir Bundali is an engineer employed by B.C. Research in Vancouver. They do a lot of R&D on materials handling and preparation, including work on biomass storage and conveying.

Nazmir described a study of woodchip handling systems in PEI that he had carried out with the assistance of Bruce McCallum in February of 1989. The study looked at component costs, operating problems and opportunities for developing alternative systems.

Dumping container trucks were the most common delivery vehicle. Three fuel handling systems were encountered. These included tractor-loaded metering bins found on a number of farm systems. Nazmir felt that this was a fringe activity that we should move away from in favour of automated systems.

He also studied below ground bins and container systems that both employ hydraulically-actuated-scraper feeders. The hydraulic scrapes appear to work well, but they do use brute force and there is some definite compaction of the fuel taking place.Nazmir posed the question— Is it the best way to handle woodchips? Can we reduce costs? The below ground bins are expensive. He found that in most cases only 60-70% of the total bin volume was utilized. Nevertheless he was surprised at how well they do work. He felt that they would not not work nearly as well if the chips were piled high at the shear wall.

Rob Brandon commented that there is no problem in that regard. The forces on the front shear wall are not that great, although the size of the outfeed port is critical.

Nazmir went on to say that another limitation of scrape systems is that they feed from the back so that the first material in is not the first material out. The scrapes' feed rate is variable, resulting in surges on the cross auger. The consequence is that the feed screws have to be overdesigned which affects the economics of the system.If we can use equipment that conveys just enough fuel we can have a much cheaper system. He noted that at the Queen's Arms Motel they are clearly trying to cut corners by using lighter augers. He said that it will be interesting to see if it works out.

Nazmir also noted that the bucket elevators of the type that we saw at Three Oaks High School were designed for fine free-flow materials, not for woodchips.

In a typical below ground bin system the conveyors cost about $25,000 and also require expensive building space. If you can reduce these costs you can use the money elsewhere.

In comparing the economics of a 300Kw boiler with a 3.5 Mw system we can see that the larger storage bin is somewhat cheaper. The cost per cubic metre of storage area for the 300 Kw system is $1500 compared to $1000 for the larger system. A comparison of below ground bins and a two- container system indicates that the container system is marginally cheaper, $1500 per cubic metre versus $1300 for the container system.

In light of these shortcomings in conventional systems, Nazmir looked at some new ideas that could result in reduced conveyor costs. One is a partially below-ground bin with an inexpensive cover with an NCF and a wrapbelt conveyor. This would be a fairly inexpensive storage system.

Ian Flann asked how long the bin would be and whether snow might get in? Nazmir replied that it would be about 20 feet long and hold about 30 cubic metres of fuel. He had not given much thought to snow blowing in, but agreed that you might have to take that into account.

Nazmir then talked about two NCF container options. The first would use containers with a built-in NCF. It would require a converging hopper and a fair bit of storage volume. There are also safety concerns regarding the high centre of gravity of the containers. In the second container option the containers would have an opening floor that would drop the fuel onto a stationary NCF. The space between would provide some surge capacity. He had not done any economic calculations on either of these intriguing concepts.

He also talked about other delivery options including the walking floor vans. The advantage with them is that you do not need to tip them.

Nazmir then talked about some new materials handling projects that B.C. Research is working on. One of them is a folding belt conveyor using a low cost

fabric belt which folds up when loaded and travels inside a PVC pipe conduit. His research indicated that screw conveyors cost about $400 per foot whereas the folding belt costs about $50 per foot. In addition to the low cost it can go around corners and span distances of up to 300 feet. They have conducted tests on a straight section spanning 100 feet and a shorter span with a 12-foot rise and two 90° bends.

Another research project involves a pneumatic transport for materials such as cedar hog fuel. These materials can be transported up to 1,000 feet in an 8-inch diameter PVC conduit. They compress the hog fuel into slugs to facilitate transport.

JOHN GULLAND—MARKETING WOODCHIP BURNERS

John Gulland owns a well established, woodheat business in Killaloe, Ontario.

John reported that they are just getting started in the demonstration of woodchip technology in Killaloe. In their first year (88-89) they installed a TP2000 30Kw woodchip burner in a woodworking shop but found that it was not capable of meeting the tremendous heat loss from this uninsulated building. He said that the unit does not operate at an output of 30Kw except perhaps in peak conditions. The TP2000 was replaced by a 65 Kw Swebo Flis fired into a conventional wood furnace. This unit was just barely capable of beating back the heat loss in the shop. The TP2000 was later installed in another building where the owner has been willing to work with it, build his own heat exchanger etc. The stoker is operating successfully on hardwood planer shavings and on chips.

John reported that, in both cases, woodchips were not replacing normal (i.e. oil or electrical) energy costs but were merely replacing roundwood which, in his area, is cheap. He said that the only advantage was increased convenience. He stressed that consumers would be very reluctant to use this technology, at the present time, if they had to pay even one quarter of the costs involved. In both installations he described the units were made available free of charge. However, when the heat load exceeds 200,000 BTU/H, or elderly people are involved, the labor problem becomes significant.

Most of John's presentation focussed on the practical challenges he faces as a retailer trying to promote woodchip systems (many of which are unproven and expensive) without any kind of marketing materials or documentation on how various systems perform. He said that he would have to build into his price to the customer all of the substantial costs he would incur trying to make the systems work effectively. This would include the development of sales materials, frequent on-site visits to troubleshoot, etc.

He said that it is impossible for a retailer to make systems available at low cost given the number of 'hidden investments' necessary to make these systems appealing to consumers. John questioned how it is possible to market unproven woodchip systems without putting the viability of his company (its money and reputation) at risk.

Dave Murray said that some of the onus must be placed on manufacturers to provide quality guarantees and informational material to help sell their products.

Rob Brandon asked if scarcity of fuel was a problem. John replied that there is an ample supply but handling the fuel is more of a problem.

Bruce McCallum pointed out that most people do not want to pay commercial rates for woodchips.

Vince Court noted that sales materials, when they do exist, are not always accurate. He said that he has had a number of negative experiences related to equipment not living up to expectations and that he will not sell anything on the basis of claims made in sales brochures.

John agreed with Vince and stressed that it is important to maintain a good reputation for the wood energy business.

Dave Murray concluded that there is an obvious need for testing various systems 'in situ'. He said that is important to be able to provide real numbers on how systems operate.

Bruce McCallum pointed out that, despite the problems, there are situations where a conversion to woodchips would offer obvious benefits in terms of convenience and practicality. He cited the example of a greenhouse operator who presently uses roundwood to heat a large area. This man must fill his furnace every few hours, day and night.

John agreed that the technology is very appealing. He said that he would like to sell 10-15 systems a year but the question is — 'How?'

CHARLES LEMAY—SWEBO AND TP2000 INSTALLATIONS

Charles LeMay is the Director of IRTA (Institut de recherche en technologie appropriée) in Clarence Creek, Ontario.

Charles reported that IRTA has been monitoring four woodchip burners. A Swedish IWABO, originally installed in Prescott, Ontario has had serious electrical problems. Three printed circuit control boards have failed. Also, the cost of retrofitting the preheater to an old water-leg boiler and the cost of the new electrical hook-up, was outrageous.The plan now is to remove the unit. They are also monitoring a 65Kw Swebo Flis burner installed at Robymétal, a sheet metal factory in the Beauce region, south of Quebec City. The plant is adjacent to a truss factory and there is a large supply of waste end cuttings available from it. To date they have been unable to find a suitable chipper to chip this wood.

Wilf Torunski suggested that a lilypad chipper might do the job. (It is designed for chipping disks cut from the ends of veneer logs.) Bruce McCallum later noted that the Finnish Laka burners will do a good job of burning trimmings and end cuttings, but their efficiency is low.

The Swebo 65 was coupled to a hot air furnace manufactured by Robymétal. The burner worked quite well. The only problem encountered was that twigs (from a hydroline brush chipper) sometimes tripped the overfill shutoff in the burner. Charles feels that his problem can be solved by stopping only the auger feed, not the fan; the twig will burn, the paddle will be released, and the auger will be reactivated.

Charles LeMay then turned to the Finnish TP 2000 30 Kw installed at the Glaude home in Rockland, Ontario in the fall of 1987. The Glaudes have been able to heat their home for two winters on 40 cubic yards of hardwood chips that cost $650. The owner likes the burner, although Charles wondered if he would have been as interested if he had had to buy the burner for the $4,000 that it cost. Bruce McCallum pointed out that the same burner only costs about $2200 in Finland and the price should be similar here if it was manufactured in Canada in any quantity. The lower price would make it much more attractive to potential Canadian buyers. Charles agreed.

The burner has performed quite well. Sticks or long chips do collect around the auger, which necessitates opening the inspection port that Charles made and removing them. Bruce McCallum noted that this problem had not occurred in the same unit tested at the Van Toever home.

The TP 2000 has been very easy to light. Andre Glaude keeps a small quantity of very dry chips on hand for lighting the burner. He puts some of them in the firetube and ignites them with a propane torch.

They did have a backfire in the hopper on one occasion. The dowser did go off, but the fire travelled past it into the bin. Fortunately, the burnback was discovered before the fuel in the bin caught fire. Marc Schneider suggested that that you have to watch the buildup of ash in the fire tube, because it can cause the combustion air to exert back pressure. Charles acknowledged that the Glaudes often let the ash build up until it formed a clinker that was usually pushed out of the fire-tube by incoming chips. Vince Court said that he has extended the holdfire on the TP 2000 for as long as 30 minutes and the unit has maintained a fire and never burned back.

Charles LeMay said that he would like to like to see more operating systems that work well.

JEREMY GODFREE—THE ACF-85 HOT AIR CHIP FURNACE

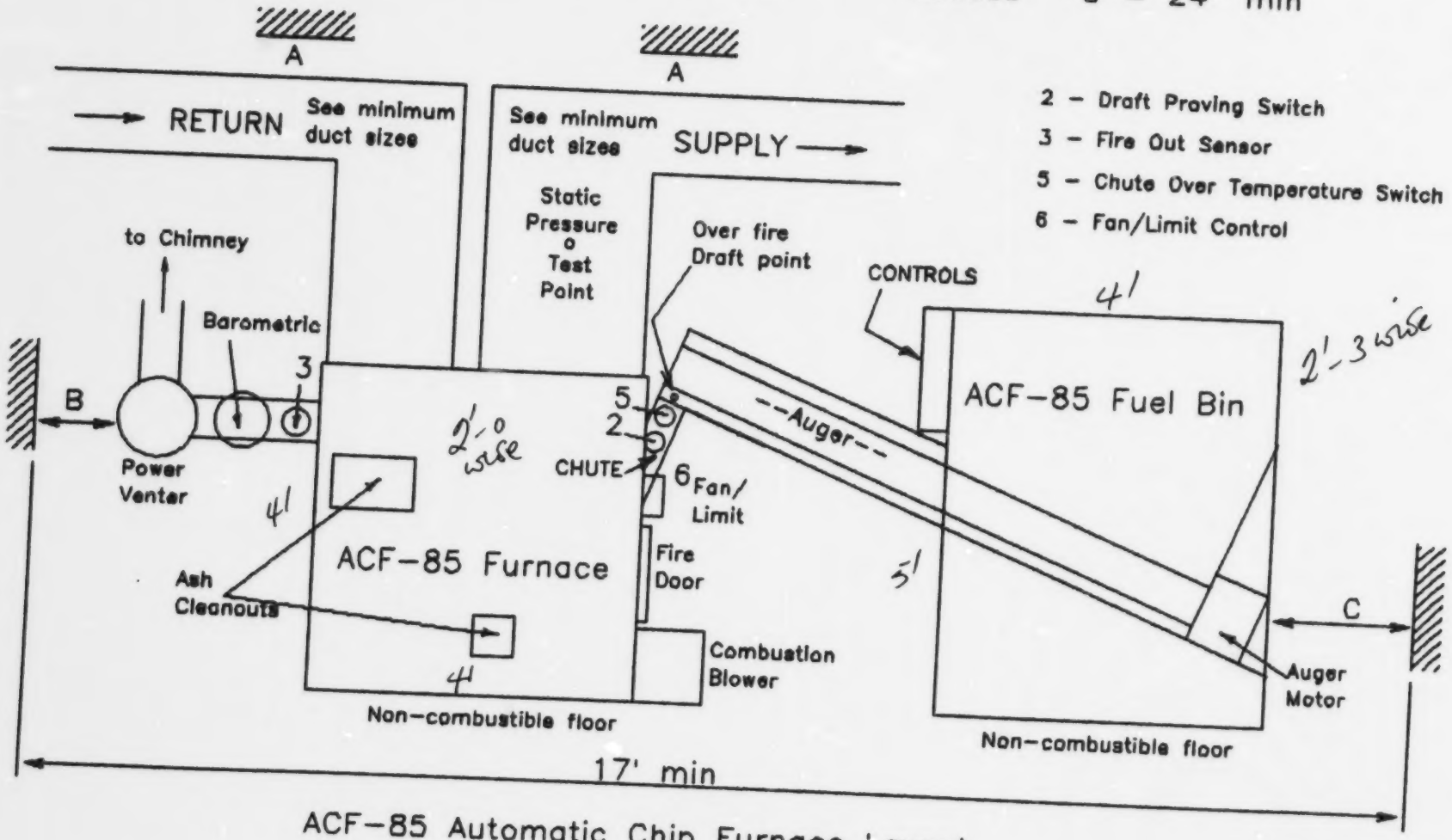
Jeremy Godfree is a product design engineer who frequently does design engineering for Parrsboro Metal Fabricators. That company received a contract from EMR to develop the American AES chip furnace into an appliance suitable for mass production.

Jeremy explained that the AES was a 1600 lb. package unit that turned out to be unsuitable for large scale production. Consequently, they had to design a completely new hot air furnace. The original contract called for the design and testing of 85,000 Btu/hr. hot air and hot water units as well as a 300,000 Btu/hr. hot air unit. However, due to cost over runs only the development of the 85,000 Btu hot air furnace was completed.

In designing the new furnace they decided to separate it into modules to facilitate transport and installation. The fuel bin is one unit and the combustion cell, fan and heat exchanger are located in the second module. The combined weight of both modules is 600 pounds. The furnace is built to oil furnace standards with 16 gauge steel. In its present form the furnace requires a linear space of 17 feet. In future models the two modules will be designed for mounting at 90° to each other to fit into more basements.

CLEARANCES

Combustibles: A = 6" min B = 18" min Access C = 24" min



ACF-85 Automatic Chip Furnace Layout

The fuel bin has enough capacity to fuel the burner at an output of 85,000 Btu/hr. for 24 hours. It has an inclined, gravity-fed 6-inch variable speed feed auger offset to the right side of the bin, driven by a 200 watt motor.

In the second module major features include: a large vertical drop and separation from the feed auger to the combustion cell; a high temperature shutoff on the fuel feed system; a front door shutoff switch; a combustion air fan; a fire-failure shutoff (with a 15-minute delay for startups); a non-tube heat exchanger to avoid fouling; two ash cleanouts; a power venter to create a forced vent draft; a combustion chamber comprised of horizontal 1.25 inch thick ceramic rings; primary and secondary combustion enters between the horizontal rings. The furnace burns both dry and green fuel. Green fuel makes for a higher fire in the combustion chamber.

On dry fuel the furnace puts out 87,000 Btu/hr, while it puts out 71,000 Btu/hr. on green fuel with much higher fuel consumption. It achieves 70% efficiency on dry (16% M.C.W.B.) and 60% on wet (41% M.C.) chips. The ACF furnace has very low emissions on both medium-fire and high-fire, but rather high emissions on holdfire.

Bruce McCallum asked if they had considered a variable speed fan for holdfire. Jeremy said yes, they had considered it and they might install it on future models.

The ACF was tested to CSA standards B366.1 for safety and B 415 for performance at the Research and Productivity Council in New Brunswick in May of 1989 It requires one year of field testing to begin this winter. It could go into production next year. The projected price is $3500 on a production run of 50 units. Parrsboro has not yet decided how the ACF-85 will be marketed.

Dave Murray suggested that the length of the furnace (17 feet) might be a problem in small homes. Jeremy Godfree agreed, but also pointed out that the ACF puts a steady 85,000 Btu/hr. which is equivalent to a 145,000 Btu/hr. oil furnace that cycles on and off. The furnace could also provide base load heat for larger buildings.

Rob Brandon asked if it would be possible to put a water-to-air heat exchanger in the plenum to supply hot water systems. Jeremy did not think that was very likely.

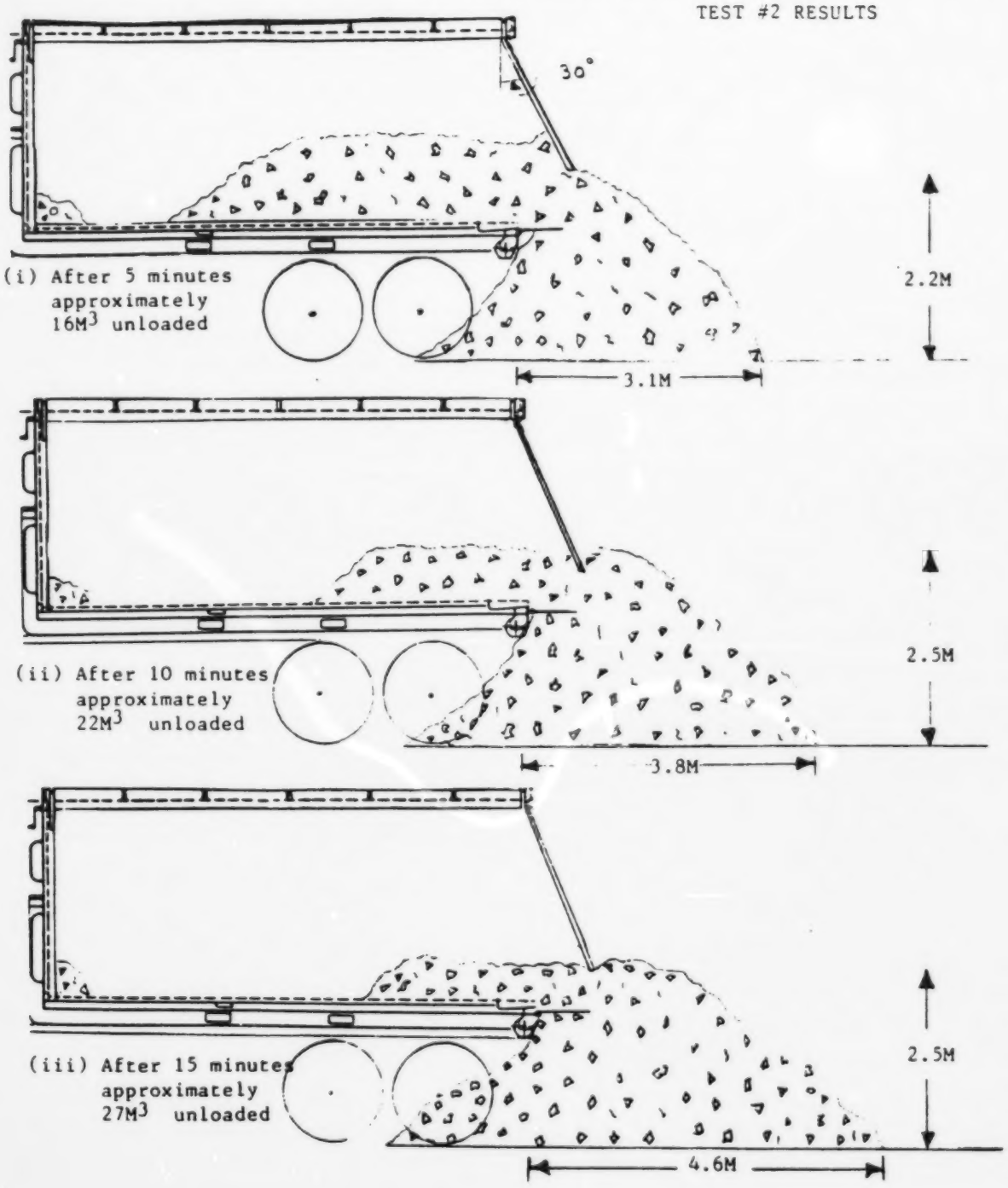
Jeremy noted that the ACF will burn sawdust and shavings in addition to woodchips, but that it was only tested and approved by CSA for woodchips. Ian Flann asked if it could still be tested on sawdust at Parrsboro. Tony Ogborne and Jeremy Godfree both seemed to think that it could be done.

Ian Flann also asked about the longevity of the furnace. Jeremy said that it was built out of 12 gauge metal to oil furnace standards and that he expected that it would probably run for about 12 years before major components needed replacement. He also felt that the ACF would likely be covered by their Parrsboro Metal Fabricators normal 5-year warranty. Ian felt that 12 years was a rather short life; his oil furnance is 28 years old.

Dave Murray asked if Jeremy felt that there could be any problem with deterioration of the combustion chamber rings. Jeremy did not think so, but said that the field testing should indicate if there is going to be a problem.

PILE CONFIGURATION DURING UNLOADING

TEST #2 RESULTS



Testing The Use Of Livebottom Containers For Woodfuel Delivery

been moved ahead when the fuel built up to a point that it started to impede the flow of fuel from the container. This trial was considered to be a relative success. The unloading time was short enough to make this a practical delivery method and to pursue it further.

Further proposed developments of the concept include: modifying the tailgate to increase the height of the outfeed port to 800mm, to increase the feed rate while also being able to pile the fuel; extending the lower flap to permit woodchips to be delivered to bins with the truck parked outside the bin; resolving the technical problems with connecting the container scrape to the truck pump. Unfortunately, the client, the PEI Dept. of Energy and Forestry lost interest in the project and it was abandoned. Bruce McCallum said he still feels that livebottom containers are probably the most practical means that we presently have to deliver fuel to above-ground woodchip storage bins.

Some questions followed about the operation of the scrape cylinder and the test procedures.

REVIEW OF TOUR SITES—CHAIRED BY BRUCE MCCALLUM

The tour sites were reviewed in the order that they had been visited, beginning with **Coles Doors Ltd.** Ian Flann noted that there was an obvious safety problem there with the fuel piled right up to the bin. Clearly it should be moved away so that a possible burnback could not ignite the entire fuel reserve. Tony Short commented that the layout was not amenable to tractor loading. Bruce McCallum said that a skid-steer loader would probably work alright. Vince Court said that Allison Coles may use the small forklift to load the fuel bin. They may also use the belt feeder.

The next site was **Three Oaks High School**. The intention according to Rob Brandon is to keep the proportion of sawdust below 30%. In Alberton they are having good results for reasons that are unclear. There was some discussion about the weaknesses of the bucket elevators. Bruce McCallum said they would probably have better success if they removed the first two photocell switches and let the feed system operate as a single fuel train, rather than two stop and go units. Nazmir Bundali also commented on the fact that they are unable to use more than about 60% of the fuel storage capacity.

The **Van Toever Residence** was the next tour site. The comments focussed on the need to finish the ceiling with an appropriate safe sheeting. Wilf Torunski also suggested that the light circuit above the fuel bin should be moved so that it would never be subjected to high heat. Nazmir expressed concern about the lack of use of the NCF at the hatchery. Bruce McCallum suggested that the most effective way to ensure that it is put into service might be to hire someone to make sure that the necessary work is done. Wayne Van Toever has good intentions to get it going, but other business concerns continue to get in the way.

The discussion turned to **Bulk Carriers Inc.** which Ian Flann felt was an impressive site. An inclined conveyor feeds from the bottom rear of a Goran Stadigh container into a mobile container which houses a surge bin plus a 130 kW Bioblast preheater and boiler. The hot water travels through hoses to a heat exchanger inside the garage. Bruce McCallum commented that it is a good site

in spite of the fact that the load of the garage is very small. The intention is to move the burner to another site at least for the summer months. This summer no other site was found. The container makes a low cost boiler room and has enough space to accommodate a much larger boiler, so the same package could be used for much larger buildings such as schools. He also noted that the original concept had been to have the container feed the burner surge bin directly without using the Goran Stadigh conveying screws. However, Jack Kelly of Bulk Carriers Inc. had wanted to use the installation to demonstrate a complete standard container feed system.

The next site was **Linden Lee Farm**. Tony Short commented that there was very little space around the burner. Bruce McCallum said that this resulted when Aike Wilting (the owner) took out the original 80Kw burner, but left the boiler in place; he installed a new boiler and the much larger 200Kw Swebo burner in the same space. The hot water is stored in a 10000 gal insulated tank, before circulation to the pipes buried in the concrete of the pig farrowing barn, and to other buildings. He has a large diesel-three phase electric, generator, with heat exchangers. He recovers 400,000 BTU/H for 3 hours each day.

The focus then turned to the **MacPhail Pig Farm** and its 130 kW Bioblast preheater plus Maco Boiler. He is burning coarse oak "sawdust" from a cabinet plant, plus a few dead pigs and miscellaneous trash. There are two 200-gallon tanks adjacent to the boiler and another 200-gallon mixing tank in the pig barn. Vince installed 2" black iron piping encased in a styrofoam box. It has 2" on the bottom and 4" on the sides and top.

Tony Short said it was a difficult site in terms of getting the fuel into the storage bin. He suggested that some kind of conveyor be used in conjunction with a dump truck. Bruce McCallum suggested that he could use a manure spreader to get the fuel in. Vince Court said that he had originally proposed a separate building but that Willard MacPhail had opted for a lean-to on his existing shop to keep cost down. He now acknowledges that it would have been better to have built a separate building for the system.

Jeremy Godfree asked how much his skid-steer loader cost. Vince thought it was about $3500.

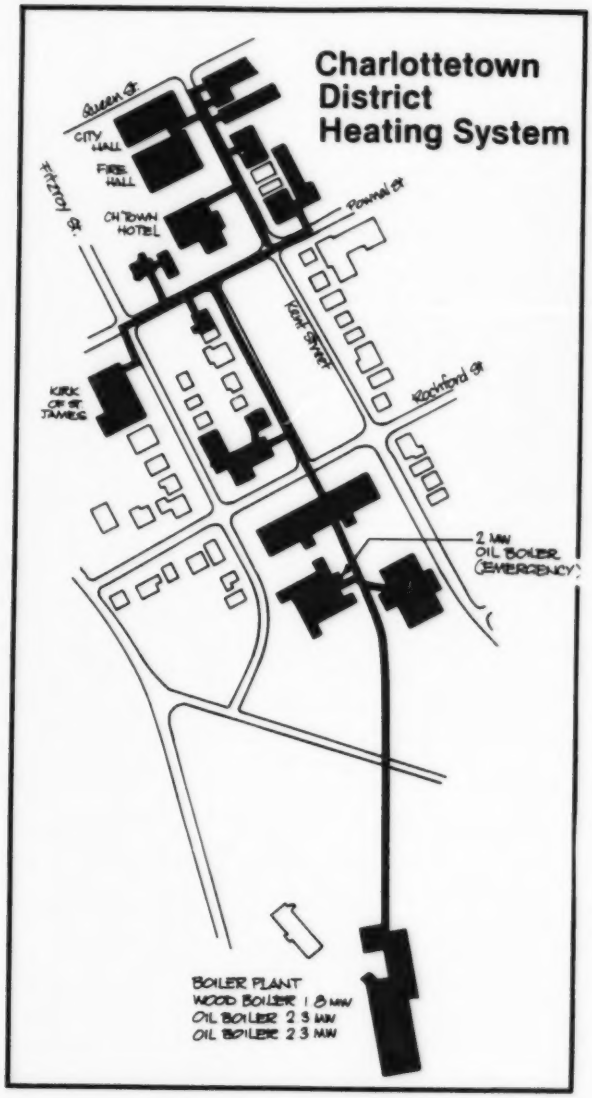
Queens Arms Motel.

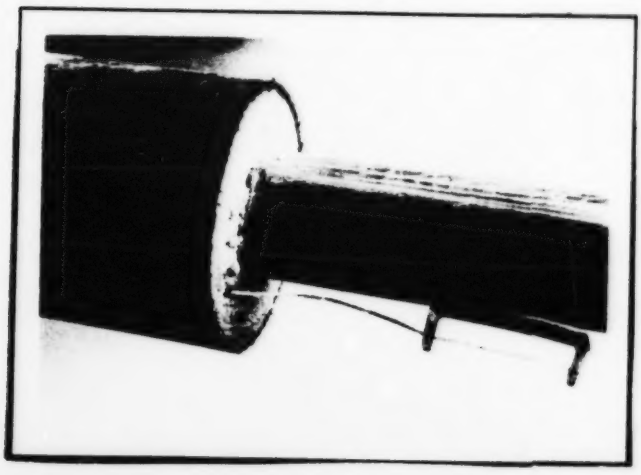
Bruce McCallum said that he expects the bucket elevator to be a major source of trouble.

A discussion then followed about the savings-finance approach used in this installation. Basically the client put up $40,000 and 62.5% of the $209,000 cost will come from E.M.R. The contractors, Ross and King, are to operate the unit for three years and receive the savings which are projected at $9000 per year. There was some concern expressed about the risks that the contractors were taking in building a permanent structure on someone else's property. Also, site accessibility is poor for large trucks, and the storage bin is small.

ROB BRANDON—DISTRICT HEATING IN CHARLOTTETOWN

Rob Brandon is the General Manager of the PEI Energy Corporation.





District Heating Piping

Rob began by saying that felt that some of the equipment that they are now using in the district heating system is probably suited to small-scale chip burning systems. These include: valves, heat exchangers and flexible cross-link polyethylene pipe which is rated for 95°C and 100 PSI. He also said that the fuel supply system put in place to meet the needs of the District Heating System has probably done a lot to build confidence in the long-term supply of woodchips on PEI.

District heating began in PEI in 1985 with the connection of the boiler plant at the PE Home and the Provincial administration buildings.In 1986 the Pilot District Heating Project was carried out and it hooked up another 13 buildings to the system. The PEI Energy Corporation bore the cost of the piping, heat exchangers and heat meters. Clients pay the same cost for heat that they would pay with oil. The advantages for them are reduced oil furnace maintenance and free space for clients that remove their boilers, as the Charlottetown Hotel is planning to do. Rob Brandon hopes that these advantages may allow the Corporation to charge a small premium over oil in the future.

There were some problems with the joints in the first project; very good quality control is needed.

In 1987 hot water lines were run from the 4 Mw chip plant at UPEI to Mount St Mary's Convent, Towers Mall, Holland College and Charlottetown Rural High School. In 1988 lines were run down Belvedere Avenue to hook up a number of apartments and senior citizens homes. This system now spans 6 km.

The UPEI plant runs at full capacity year around. It meets the vet college air conditioning needs as well as the total domestic hot water load in the summer months. The winter peak load is 13 Mw and oil boilers pick up a major portion of it.

This summer (1989) extensions were begun to the PEI Home system along Kent and Rochford Streets. These extensions are being made without any Federal Government subsidies.

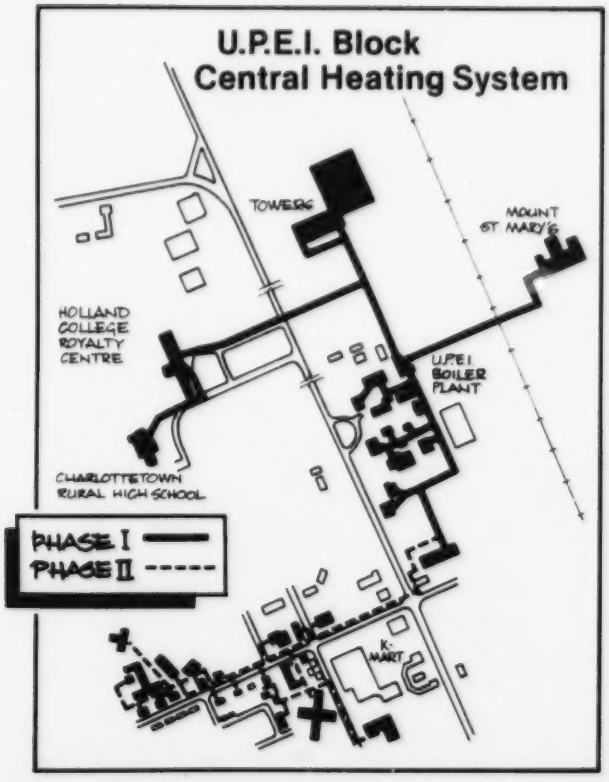
The technology employed is largely Scandinavian. Thin-wall high pressure (250PSI) (Schedule 20) pipe from Brown Bovari of Denmark has been accepted by our boiler inspector. This pipe is cheaper than North American pipe (Schedule 40) and it has the advantage that it can bend to go around gentle corners. No corrosion has occurred to date in the system. Obtaining approvals for the pipe and other components has been a long and arduous process. Transmission losses are 6-8% annually.

The joints are welded and then a muff is fitted and the cavity is filled with foam mixed from two separate bags. A leak detection system can identify a leak within 1 metre of its location.

In laying the pipe they try to keep off the street to minimize costs. The trenches are about 1 metre deep.In a current downtown project the Corporation is laying its pipe in the same trench on top of the city's lamp post lines and Maritime Electric's underground power lines.

In the early projects they put in expansion elbows which are costly and put stress on the joints. In the later projects they put the lines in cold and then heated them to allow them to expand before installing friction anchors at each end and then backfilling. The main lines are now done in 300 metre sections with compensator joints that are welded after the line has been heated and expansion taken place. This Scandinavian technique is much cheaper. The smaller lines go in cold with no allowance for expansion.

4 MW U.P.E.I. Chip Plant



The flow rate and the line temperature are varied according to the demand. They operate it at 80°C in summer to provide domestic hot water and 120°C in winter for space heating.

Rob went on to say that the PEI Energy Corporation uses compact Elge heat exchangers that are now built in Charlottetown by a small company called Itek. Since they produce heat on an instantaneous basis there are no tank radiation losses. They also use Finnish Naval ball valves that are cheaper and apparently better that North American valves. The Finnish valves are either on or off.

It is the PEI Energy Corporation's intention that the district heating system will become a full utility at some point in the future. The Public Utilities Commission has agreed to leave it in the hands of the PEI Energy Corporation until the system reaches an appropriate utility size.

Rob Brandon's presentation ended with a brief discussion of three district heating projects that all employ similar Scandinavian district heating technology.

JOHN TE RAA—SCHOOL CONVERSIONS IN PEI

John te Raa is Project Manager with the PEI Development Corporation

John gave a slide presentation which focussed on three schools in Kings County and six systems in Prince County. In 1982 the PEI Energy Corporation installed a woodchip heating plant in Kings County Memorial Hospital.

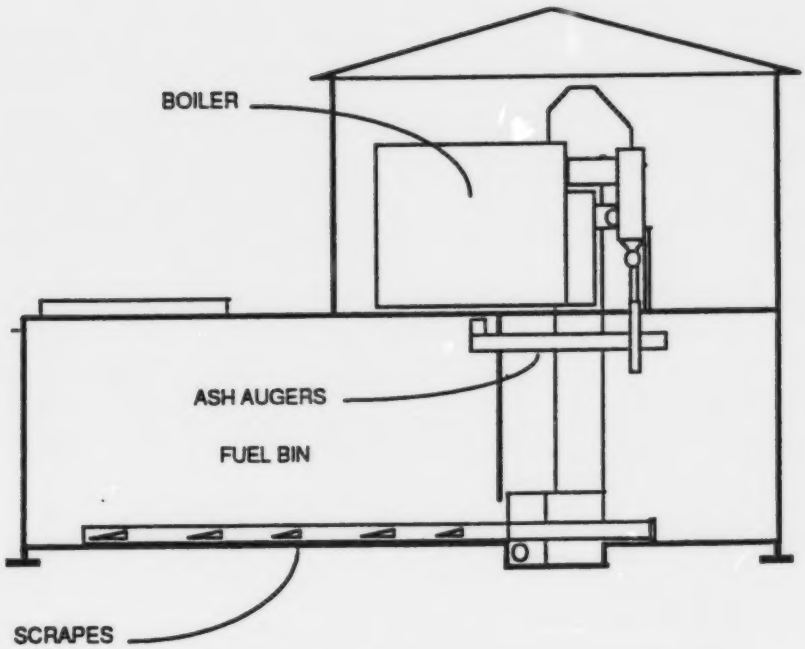
In 1983 they installed a 270Kw Northfab system in Montague Junior High School. John reported a number of problems with the system. He said that it was designed for sawdust, not green woodchips. The augers were too light and were damaged on a number of occasions. There was no refractory in the boiler. Combustion was poor on green fuel and there were major creosote problems. The unit was ultimately taken out.

In 1986 they installed a 700 Kw Silva system in Montague Junior High School and ran a line to the smaller Senior High School. This was more satisfactory. He said it was the first installation with an automatic de-ashing system and that it is operating very well.

In Morell High School, they installed the boiler that had been removed from Montague Senior High, but using a new combustion cell. They had hoped to use a chip container system but could not convince to school board to do so. They went with an in-ground bin and bucket elevator design which works fairly well.

John went on to talk about six Prince County installations which used modular units manufactured at Georgetown Shipyards. These included: Hernewood Junior High(400Kw); WestIsle (800Kw); Three Oaks (800Kw); O'Leary (450Kw); Alberton (450Kw).

In this design the combustion cell and bucket elevator are shipped in one module and the boiler in a second. All of the installations used separate boiler rooms (50 to 100 feet from the school), below ground fuel bins and bucket elevator systems.This design incorporates moving step grates and an ash auger at the front of the combustion cell.



Silva Compressed Chip Plant Layout

John said that this very compressed design saved money on civil work. He estimated a $45,000 saving. The boiler house is constructed, the roof lifted off and the equipment lowered into place in the modules. All the major equipment can be put in place inside the boiler room in four hours. He reported that the bucket elevators have worked fairly well when fuel is consistent. However, there have been problems with fuels that have sticks and a higher percentage of sawdust. Twigs and oversize pieces of fuel become trapped in the hopper which acts as a sorter. The presence of these oversize pieces causes the infra-red sensor, which regulates the fuel supply, to shut down the feed system.

Another concern is fouling of the boiler tubes. When using fuel with high sawdust content, the system must be shut down every three weeks for tube cleaning. This is done using a type of vacuum cleaner and can only be carried out when the burner has been shut down and allowed to cool down for 24 hours. A less disruptive and less costly method, although not as effective, is to punch the tubes out every two weeks using a brush on a long rod. This can be done when temperatures are higher. John said that operators do not always co-operate in this area. He noted, too, that limiting the sawdust content will reduce the fouling problem.

There have been problems, too, with the interfacing between oil and wood. This, he says, is largely a question of educating the operators to allow the wood boiler to control the system. In some cases operators have been nervous about adjusting the oil boilers. These are often set too high causing the wood system to cut out and let the oil boilers take over when they do not need to. The installation of three-way valves has eased the problem in some installations.

Rob Brandon commented that there is an ongoing debate between the PEI Energy Corporation and the manufacturer (Silva) over the optimum size of woodchip plants. The conventional wisdom is that plants should be sized to carry only the base load and oil boilers should take the peaks. Terry Gunnell of Silva argues that at Three Oaks, for instance, it was worth an extra $10,000 to put in a larger 800 Kw boiler that can carry most of the peak load of the building, given that the burners have a good turndown ratio.

Ian Flann asked if there was a cost saving in having six units manufactured under one contract. John reported that there were no savings over the Montague Jr. High installation. Although they opted for the cheapest design tendered, the inexperience of the manufacturers tended to push costs up.

Ian asked if there were any disadvantages in building new boiler rooms separate from the school building. John said there were none because the existing boiler rooms at all of the sites were unsuitable anyway.

A discussion ensued on the merits of vertical tube boilers. John said that they would like to use vertical tube boilers. Rob Brandon pointed out that there are none being built in North America and Swedish vertical tube boilers built by CTC Osby are not approved to ASME standards.

Ian Flann said that Matheson in Nova Scotia will build one if they are supplied with the drawings. Then he posed the question—Is the vertical tube boiler design sufficiently superior to warrant having it manufactured?

John said that it is. Rob Brandon pointed out that because they do not foul as readily they would allow you to burn more sawdust, but that design costs are prohibitive and the market is small.

Ian concluded the session with a description of a chip-fired installation in Armstrong, Ontario. The system is being installed with no Federal subsidy by the Ontario Board.of Education. The cost for oil there is 39 cents a litre. (This is double the cost in PEI). Ian said he is convinced that there is a big market for chip fired systems in schools in Canada.

CHARLES LEMAY—STANDARDS UPDATE RE CHIP BURNERS

Charles LeMay is the Director of IRTA (Institut de Recherche en technologie appropriee) in Clarence Creek, Ontario.

Charles talked briefly about CSA standards as they relate to chip burners. CSA B415 is a performance and emissions standard that was designed for woodstoves. It is being revised to encompass roundwood-fired furnaces and chip-fired systems.

Charles felt that emissions regulations might be a source of trouble. Environment Canada is developing emissions guidelines with the provinces. Systems below 1 million Btu/hour have been left to C.S.A.

Tony Ogborne commented that one problem has been that it is difficult to design for a variety of fuels. They presently test units with Douglas Fir chips so that they are using the same fuel for all types of combustion appliance.

Charles said that one consolation is that chip burners have very low emissions. They are all below EPA standards.

Ian Flann pointed out that it would be wise to have documentary evidence that chip burners are clean as a protection to the industry in the event of legislation against wood -fired appliances.

Charles made the point that although chip burners are very clean on highfire they are much dirtier on holdfire. This could be of concern to EPA. Charles said that it is important to clean up our act on holdfire. Automatic ignition systems were suggested but these, too, have problems.

Dave Murray said that this was a bit of a red herring because in net terms the emissions are very low from chip burners. Expressed in grams/megajoule the emissions are still low.

Ian Flann commented that all the wood combustion units in Canada produce only about 10% of the emissions of forest fires.

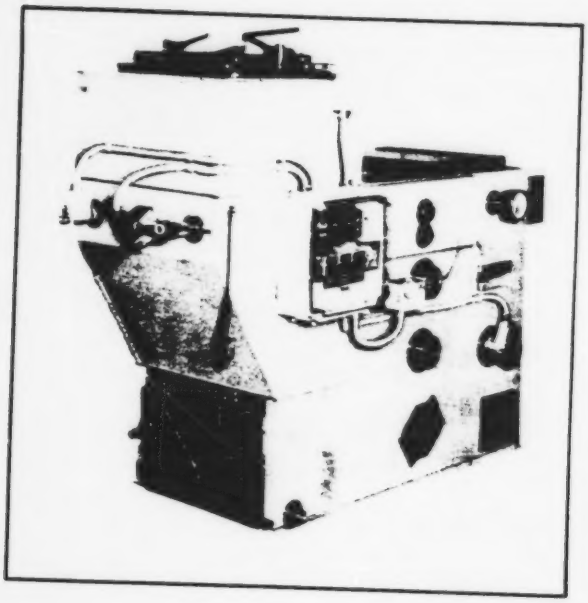
Bruce McCallum suggested that the standards employed in other advanced countries such as Denmark and Germany should be studied. He said it was possible that they are more realistic than the standards being set in Canada.

The talk concluded with a brief discussion on woodstove testing in the U.S.

TONY OGBORN-CERTIFICATION OF THE ACF AND THE LAKA

Tony Ogborn is an engineer with CSA (Canadian Standards Association).

Tony began by saying that there is no provincial legislation that requires certification for woodburning appliances, but some insurance companies ask for it. The CSA B 366.1-M87 Solid Fuel Central Heating Appliances is basically a



LAKA Boiler

safety standard. Appliances tested to this standard are examined for potential hazards. They are not tested for function. For example, if bridging occurred in a fuel hopper it would not be of concern to CSA unless it posed a safety hazard. B415 is a performance standard.

The fuel and the test sequences are the same for all appliances tested under these standards.

Tony acknowledged that the chip burner industry is still at an infantile stage but felt that it is still in the manufacturer's interest to to have a unit tested. For example, CSA tests for hot spots. If these exist they could result in excessive expansion or degradation of materials and greatly shorten the life of an appliance.

The wording of standards is a very arduous task for committee members. CSA standards are intended to act as design guidelines without restricting manufacturers in their technological approach. European standards are more like design manuals and they are more confining. Nevertheless, they still succeed with technological innovations. Standards represent many, many years of experience that are available at negligible cost.

In the certification of the 29 Kw Laka boiler and the ACF-85, CSA examined things such as the function of the limit controls, temperatures and ash buildup in the heat exchangers.

Tony then talked about the Laka boiler and how the unit has separate oil and wood chambers that do not operate simultaneously. Todd Fraser commented that the Laka burned better on dry chunky material , particularly lumber trimmings and dry (11.6%) peat It put out 40 Kw on the dry peat with negligible emissions.

Tony said that it is very common for them to discover problems that must be corrected in all appliances. Sometimes the tests must be halted until the manufacturer figures out how to resolve a particular problem. Sometimes such a problem cannot be solved. Tony gave an example of a gravity-fed burner that could explode under certain circumstances.

The 29 Kw Laka will be certified. Several tests have yet to be carried out. These include: testing the unit for possible simultaneous firing (oil and wood) when using a DHW coil; and testing the burning on peat of 30, 40 and 45% M.C. It will not be certified for electric backup.

Tony said that certification costs $6,000 to $10,000. It is cheaper for Canadian companies. Obtaining proprietary information from foreign companies is sometimes a problem. CSA keeps such information on file and it does not include the data in its test reports.

Vince Court and Tony Ogborn then had a brief discussion about segregating low and high voltage parts of the electrical control panel. Tony suggested that Vince could contact him for advice, although CSA has to charge for such advice.

WHAT NEEDS TO BE DONE?

Ian Flann asked us to focus on future priorities for R&D and the general development of the woodchip combustion in the small commercial field. Tony Short suggested that one priority area should be improving the **cleanliness of combustion**, particularly for burners in the holdfire mode. Emissions are going to be very critical in the future. Tony said that the Vallsta worked well, although there was some pollution in the startup phase. Vince Court asked if it might be possible to have a small separate chamber for a dry startup fuel such as pellets or shavings. Other techniques that Tony had seen included: using propane which was tried by David Libby, and hot air with an electric coil such as the Vallsta.

Bruce McCallum suggested that we consider the Twin Heat approach in which they use a variable speed fan for holdfire combustion air. The fan speed is adjusted to the minimum speed at which clean combustion can be achieved during holdfire. Bruce asked if it would not make sense to do a small study on the state of the art of clean holdfire combustion. Vince Court said that his new control panel will allow adjustments to the fan speed during holdfire.

Ian Flann asked if we need to do **more testing**? Ron Braaten of the CCRL (Canadian Combustion Research Laboratory) said that they would be prepared to conduct some cost-shared R&D for companies. Charles LeMay felt that there is probably a shared need for R&D with roundwood furnace manufacturers, particularly regarding suitable combustion chamber ceramics. Tony Short felt that if you can maintain a very hot combustion chamber you can have a fairly long holdfire period and still have the fire come back up quickly to the temperatures necessary to achieve efficient and clean combustion. More efficient insulation would lead to smaller and lighter appliances.

Bruce McCallum proposed that the **development and demonstration of new automated materials handling systems** for small commercial woodchip plants in the 200-400 Kw range be a priority. We must reduce the capital costs of fuel handling systems, while improving their reliability if we are to achieve greater market penetration for woodchip heating. Charles LeMay commented that we have to implement all the economic energy conservation measures applicable to a particular school before we determine the appropriate burner size.

Marc Schnieder suggested that we **concentrate our efforts on a few appliances** and not waste time and money on a lot of machines that will never be suitable for commercialization in Canada.

Bruce McCallum suggested that there is a need for an **information handbook on small commercial chipping.** It could be a handbook that included case studies of successful small scale chipping operations. FERIC did a similar study on larger commercial chipping operations. Tony Short said that UNB does a lot of work on optimizing forestry operations and that this might be something for them. He pointed out that a study they did in the early 1980s indicated that manually-fed chipping was not commercially viable. Bruce acknowledged that small scale chipping is not suitable for commercial production, but added that farmers such as Aike Wilting still wish to do their own chipping. They feel that they have the labour on hand and that it saves them money over buying fuel from Bulk Carriers. People like him and Willard MacPhail and Wayne Van Toever need a handbook of some sort to get them up on the learning curve as quickly as possible.

Vince Court suggested that **developing some way to dry sawdust** would be very helpful since there is lots of it. There was a brief discussion about the continued interest in woodfuel drying in New Brunswick. Ian mentioned that a man in Vermont uses an old furnance blower for only one-half day each fall to dry his winter's supply of chips sufficiently.

Tony Short suggested Bruce McCallum or someone else be hired to put together a **questionnaire** to ask all interested parties in Canada what they think needs to be done before we establish the priorities. Dave Murray suggested that some sort of data base be established.that we could all tap. Charles LeMay said that he preferred a **newsletter** to a data base. He said that a data base such as BITTS is very limited. It was agreed that finding some way to finance it is critical. Tony Ogborn asked for a woodchip encyclopedia.

Tony Short raised **heat transfer** as another area of concern. A brief discussion followed on corrosion in wood and gas and oil furnaces. Ian Flann said that he got nowhere when he tried to interest boiler manufacturers in **vertical fire-tube boilers**. He felt that the space saving aspect of vertical tube boilers is important as well as the fact that they are slower to pick up a deposit on the tube surfaces.. Vince Court said that he has found water tube boilers to be the most user friendly, they don't foul up as readily and they can easily be cleaned while the system is in operation. Subsequently a boiler manufacturer said that cleaning off the upper surfaces of the tubes was often difficult. Tony Short asked if there are any ways to prevent fouling. Jeremy Godfree said that staggered horizontal pipes provide better heat transfer if they are clean.

Ian Flann mentioned the 50 Kw vertical tube Etna boiler which is at Pat Corrigan's shop. He suggested that Vince have a look at it. Charles LeMay said that it was a fairly well designed boiler, with good access cleanouts at the top and bottom of the heat exchanger.

The meeting adjourned at 12:04 with a tribute to the contribution that Ian Flann has made to the wood combustion field, by Tony Short. Ian thanked Tony and everyone else for their support and said that he hoped to remain active in the field.